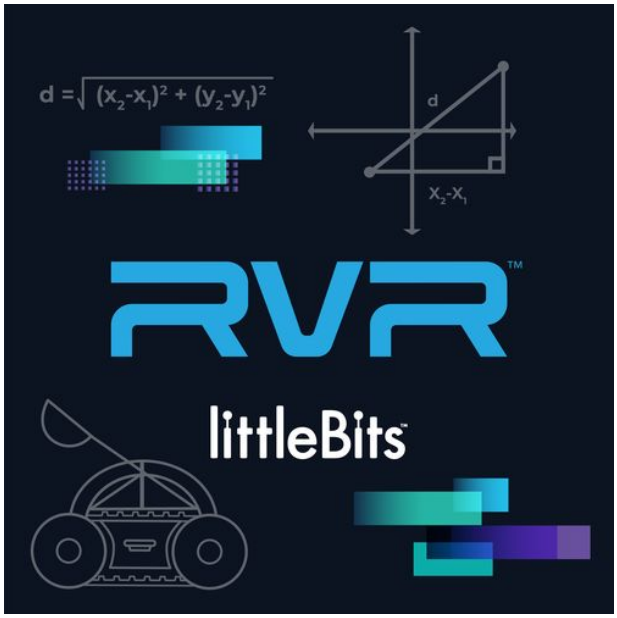
LESSON

# RVR + littleBits: Ball Launcher




## Overview

Let's play ball! How many points will you score in this mobile ball-launching game? In this activity, students will combine their RVR with littleBits and challenge their classmates to a game of ball-throwing.

**THE CHALLENGE**

Using RVR & the littleBits STEAM Student Set, students will create a mobile ball launcher that will be used to play a game.

## Lesson Tags

**GRADE LEVEL:**

Elementary, Middle (grades 3-8)

**SUBJECTS:**

Technology, engineering

**DIFFICULTY:**

Beginner

**DURATION:**

2 x 50 minute class periods

**PREREQUISITE KNOWLEDGE:**

- littleBits basics
- littleBits Invention Cycle
- Sphero RVR basics

## Supplies

### Technology:

- Sphero RVR
- littleBits STEAM Student Set

### Tools Used:

- Tape
- Pencil/pen

### Other Materials:

- Scratch paper
- Assortment of craft and recycled materials

## Description

### LESSON OUTLINE:

**INTRO:** Introduce the lesson prompt and assess students' current knowledge.

**CREATE:** Groups of 2-3 students brainstorm ideas and create a plan for their RVR and littleBits designs. Then, they will build their prototypes.

**PLAY:** Students test their prototypes.

**REMIX:** Students adjust and customize their designs to improve functionality.

**SHARE:** Students challenge their classmates to a game using their new ball launchers!

### LESSON OBJECTIVES:

- Demonstrate a basic understanding of input/output, and electric current.
- Construct an invention with littleBits that launches an object.
- Modify the invention to be triggered by the RVR's movement.
- Program the RVR to move forward.
- Use the inventions to play a ball-launching game!

### ASSESSMENT STRATEGIES:

**FORMATIVE ASSESSMENT**: Testing, feedback, and redesign provide excellent opportunities for formative assessment. Circulate the classroom as students work, assessing their use of the RVR and Bits, teamwork, and any other relevant skills you wish to focus on.

**SUMMATIVE ASSESSMENT**: Evaluate students understanding and completion of final projects during the "Share" portion of the lesson.

Documentation for this lesson can be achieved through:

- A log of their invention / exploration process - whether written in a journal/notebook or through the use of media
- A presentation or media component capturing their process (image or video)

## Standards

### NGSS

**3-PS2-2:** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

**5-PS2-1:** Support an argument that the gravitational force exerted by Earth on objects is directed down.

**3-5-ETS1-1**: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

**3-5-ETS1-3:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**MS-P2-2:** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

**MS-ETS1-1:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

**MS-ETS1-3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

## Vocabulary

| | | |
|---|---|---|
| Accuracy | Launch | Prototype |
| Projectile | Target | |

## Resources

### SUPPORTING LINKS

Sphero RVR + littleBits - Ball Launcher

Invent a Throwing Arm Instructions

Invent a Throwing Arm Lesson Plan + Video

### TIPS & TRICKS

**Tip #1:** Keep an eye on the clock. Some students will want to spend too much time in the Create stage, and some students will try to speed through it.

### PACING (2 x 50 minute class periods)

**Day 1**

Prep + Setup

Intro (10 mins)

Create (30 mins)

Play (5 mins)

Close (5 mins)

**Day 2**

Prep + Setup

Intro (5 mins)

Create (10 mins)

Play (5 mins)

Remix (10 mins)

Share (15 mins)

Close (5 mins)

# Instructional Steps

## Step 1: SETUP

**DURATION:** 15 minutes prior to class

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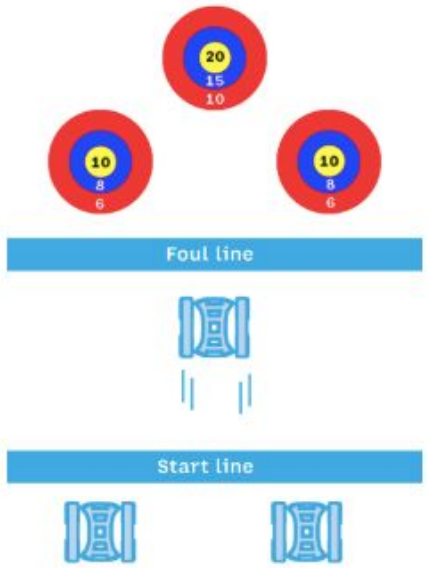
This lesson can be done individually or in small groups (2-3 students).

Each group will need one Sphero RVR and one littleBits STEAM Student Set. You will need to clear an area of your classroom that will allow some room for the RVR to drive around and enough space to create the game. You will also need scrap paper to turn into paper balls that will be used to play the game. Set up the game space using butcher paper, poster board, or other supplies and create the starting line, foul line, and scoring circles. You can design your own game space or model it as so:




Set up a central location in the classroom for assorted materials and tools.

**NOTES**

- You should use a classroom timer or digital timer to help keep students on track.
- Optional devices for documentation: point and shoot cameras, cell phones, computer/tablet cameras, voice recorder.

## Step 2: INTRODUCE

**DURATION:** Day 1: 10 minutes, Day 2: 5 minutes

**Day 1**

Begin by eliciting a discussion and assessing students prior knowledge on a real-world comparison to the invention students will be making.

**Ask:** Has anyone seen a catapult before? What does it look like? How does it work?

**Discuss:** Show students the Invent a Throwing Arm video and allow for students to share their ideas. Then discuss how a catapult is a machine that launches an object towards a desired target. It holds the object in a basket at the end of a long arm, then launches it forward to fly through the air in an arch and land on the intended target.

**Ask:** How could you launch a ball to fly a farther distance? What about shorter distance?

**Discuss:** Allow for students to share their thinking and prompt them by drawing examples on the board. Students should be able to discuss how different forces and paths that the ball takes can affect how far it travels. Guide students to understand simple ways to get the ball to move further, such as moving the catapult closer to the target, as well as more advanced thinking, such as the angle at which the ball is thrown and how flat the arch is.

### Introduce the Challenge

Explain that students will combine their RVR and littleBits to create a mobile ball launcher that they will use to challenge their classmates in a ball-launching game! They will use littleBits and the littleBits Invention Cycle to create a launching arm, then they will program their RVR to move forward and activate the launching arm during game play. The activity will be broken up into the following steps.

**CREATE:** Use littleBits to create a throwing arm that is activated by an input trigger, then program the RVR to move forward so it can activate trigger.

**PLAY:** Test your invention for modifications. What worked, what didn't work? It's 100% OK if there are issues - that's how inventions are built!

**REMIX:** Use this time to make changes to your inventions.

**SHARE:** Share their inventions by challenging classmates to play!

Then, walk through the learning sequence, and the learning targets. Show students the game board setup and describe the rules to the game. The rules are as follows:

- Each team will complete 3 paper ball launches per round.
- There are a total of 2 rounds.
- Each ball launcher invention must use an input Bit to trigger the servo mechanical arm.
- Teams may place objects between the start line and foul line to help instigate the input of their invention (e.g blocks to activate a button Bit; a flashlight to activate a light sensor Bit).
- RVR must be programmed to roll the invention towards the foul line.
- Paper balls must land more than halfway in a ring to be awarded the points.

Finally, divide the class into groups of 2-3 and have them set up their workstations.

**NOTE:**

- Depending on students levels, feel free to adjust some of the rules to how you see fit. For example, you may allow for students to complete more or fewer launches per round, or have more rounds if time allows.

**Day 2**

Briefly remind students of expectations and where they should be in the Invention Cycle.

## Step 3: CREATE

**DURATION:** Day 1: 30 minutes, Day 2: 10 minutes

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**Day 1**

### Build a Throwing Arm

Follow the instructions on page 46 of the Invention Guide on How to Invent a Throwing Arm to guide students in building prototypes of their launchers. Note that students will need to make some adjustments to adapt this throwing arm for combination with their RVR. They will need to replace the p1 power with the p3 USB power to connect the littleBIts circuit to the RVR. Students will be attaching their mounting boards to the top of the RVR, so make sure that:

- When the mounting board is laid flat on top of the RVR, the mechanical arm starts out pointing towards the BACK of the RVR.
- When the button is pressed, the mechanical arm/basket should wing upwards/forwards towards the FRONT of the RVR.

**NOTES:**

- Depending on students' levels and time allowed, you may wish to walk students through the entire Invent a Throwing Arm Lesson Plan to give them a deeper understanding of core concepts.
- For more on how each Bit works, check out the Bitopedia to get students' brains moving.

- For extra help, check out the getting started activities for RVR on Sphero Edu.

### Attach to RVR

After building your launcher, attach your invention to RVR using twist ties, velcro, tape, or any other means. You may have to adjust your invention to allow RVR to roll and trigger the ball launcher.

- Try using tape, velcro, or sticky tack to have the button at the front of the RVR acting as a bumper to sense when RVR runs into something.
- Use a roll block to program RVR to roll into an object to push the button.

**NOTES:**

- There will be time during the next session for students to finish attaching their circuits to their RVRs. However, by the end of this lesson students should at least have an idea of how they will use their Bits and attach them to the RVR to create their ball launcher.
- Delegate! Recommend to students that they should divide the work among group members. For example, one student works as the record keeper, one works as a timekeeper, one on the RVR program, one on the Bit launcher etc.

**Day 2**

### Finish Prototyping

Students should dive right into the second session of this lesson finishing their mobile ball launcher. They should make sure that their launcher is securely attached to their RVR and is set up to be triggered correctly when rolled forward.

## Step 4: PLAY

**DURATION:** Day 1: 5 minutes, Day 2: 10 mins

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**Day 1**

### Test the Launcher

Students should test their launchers to see how well it throws! Does it work as planned? If students are finding their prototypes aren't working, they should:

- Check the trigger:id they press the button all the way down? Is it in the right place in their circuit?
- Check the power: Make sure the RVR and littleBits circuit are powered on and check that cable connections are secure. Check for low batteries as well.
- Check that the servo motors: Make sure the servo is set to TURN mode. Remember, servos can be sensitive to heavy weights, so you may need to lighten the load if it starts shaking.

Students should make any adjustments necessary to insure success!

**Day 2**

### Test the RVR + Launcher

Have students test out their new completed RVR + littleBits Ball Launcher! Did everything work the way they planned? What could be better?

**NOTES:**

- If time allows, have students share their creation with another group and collect feedback on what could be improved.
- Remind students to focus on the successes of their inventions during this time as well! While this time is meant for students to identify aspects that can be improved with their projects, they should also take some time to revel in their awesome animal inventions!

## Step 5: REMIX

**DURATION:** Day 2: 10 minutes

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Students should use this time to make any necessary improvements to their inventions! They should test their launcher and think about how they could improve it. Guide students to experiment with mechanics: Which parts of the launcher can be changed to influence distance, accuracy and speed? Students should alter one variable at a time to best assess the impact of the design change on the performance of the launcher.

Could they change the input trigger on their invention? How could using other Bits make their launcher better? Students should get creative !Experiment with mechanics:

- Which parts of the launcher can be changed to influence distance, accuracy and speed? Alter one variable at a time to best assess the impact of the design change on the performance of the launcher.
- How does changing the length of the mechanical arm impact the throwing distance?

Students could try using different objects for balls, of varying mass and shapes, or altering their bucket.

- What object gets thrown the farthest?
- What observations can be made about how the size and shape of the object affects the speed and distance traveled?
- What happens when you change the bucket size or shape? How does it affect the throw? Do any changes make the throw more reliable? More accurate?

How could using other Bits make it better? For example, students could:

- Switch the button with a pulse Bit for automatic firing.
- Add a number Bit to count the number of shots takes.
- Create a moving target with one of the motors and the other mechanical arm.

Make it engaging: What other games can be played with the launcher? Ideas include basketball, mini golf, or bowling; new games are also encouraged! Consider how many players, what the objectives and rules are and how players will keep score.

Added challenge: Try using the number Bit + an input on the target for recording score. Collect and record data from multiple trials from one individual, or single trials between multiple users. What can this information tell the game designer about difficulty or individual player performance?

**NOTES**

- Keep your eyes peeled for any groups going into meltdown mode thinking “Our prototype is terrible! Tear it apart!” If a group is disappointed with how their invention is going, celebrate their efforts and emphasize failing forward - e.g. learning from mistakes.

## Step 6: SHARE

**DURATION:** Day 2: 15 minutes

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### Play the Game!

Now that students have finished their launchers, it’s time to play the game! Gather the class, then:

- Have students take turns among teams launching their paper balls into the targets. Each turn is 3 ball launches.
- Tally up the total score for each round
- Highest total score after two rounds wins!

***TIP:*** *Encourage students to practice good sportsmanship while playing! Keep an eye out for groups who may get overly competitive or sensitive to not winning the game. Remind students of their amazing feat in creating their ball launcher in the first place!*

To add to the challenge, you can have students play Round 1 of the game before the remix, then have round 2 be after the remix stage. This allows students to see the need for the remix stage and gives them time to brainstorm some new or better solutions. You could then have final scores be the net change of scores from Round 1 to Round 2 to highlight the importance of remixing and iterating on ideas.

Once finished playing the game, elicit a class discussion by asking the following:

- What is one new thing that you learned during this challenge?
- What changes did you make during the remix stage? Why did you make those changes?
- Did RVR’s program change how your ball launcher worked? How so?

## Step 7: CLOSE

**DURATION:** Day 1 and 2: 5 minutes per class

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At the end of each class, have students return their RVR, Bits and any other materials to their designated areas.

Students should take apart their inventions and put away the Bits according to the diagram on the back of the Invention Guide. Students should clean up their workspace and return any usable materials/tools.